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THE USE OF LOGIC TREES IN MILITARY PERFORMANCE TESTING

Raymond L. Erickson

INTRODUCTION

The creation of an effective performance test is normally the culmination of exhaustive analysis and planning. Innumerable methods have been devised to ease the test design effort, and all doubtlessly contribute to the development of realistic, objective and comprehensive tests which are capable of providing feedback specific enough to control instructional quality. Despite the plethora of test design techniques, the United States Army Adjutant General School has found one analytical tool to be far superior to all others in the construction of valid instruments for the measurement of student achievement. At the Adjutant General School, the first significant step in the creation of a performance test is the construction of a Logic Tree.

DEFINITION

The Logic Tree is formally defined as a schematic representation of a mental decision making process and the actions that result from such decisions. Quite simply, the Logic Tree is a decisional flow chart. The Logic Tree is decisional in that it graphically depicts each of the decisions which must be made in the performance of the task being analyzed, from the initiation to the completion of that task. The Logic Tree is a flow chart since each of the decisions in the performance of the selected task is placed in its most logical sequence. Consequently, to Logic Tree a task is merely to list all the decisions which must be made in the performance of that task, from start to finish, in their most logical order.

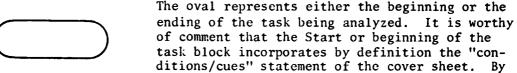
LOGIC TREE CONSTRUCTION

The structure of a Logic Tree can be best described by dividing the analytical tool into its two component elements: 1) the cover sheet; and, 2) the decisional schematic.

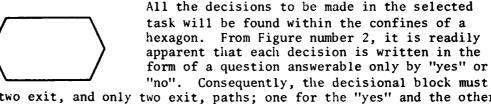
The cover sheet of a Logic Tree performs the same function as the table of contents in a textbook. The properly completed cover sheet should disclose information sufficient enough to inform the reader whether or not this is the Logic Tree he desires to read. Figure number 1 demonstrates the content and format of a cover sheet. At the top of the cover sheet is found the necessary statements of a Training Objective. The Training Objective will identify the task being analyzed and the conditions (givens) under which the task is to be performed.

The conditions segment of the Training Objective must also include the cue or the stimulus which causes the task to be initiated. Also to be noted on the cover sheet is the listing of the Source Data. Such a listing ensures that the reader can check upon the accuracy of the Logic Tree's content.

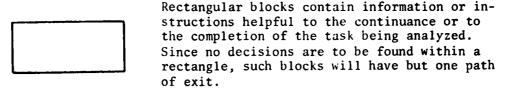
The decisional schematic of the Logic Tree is merely a collection of blocks and directional lines. Figure number 2 depicts the structure of a Logic Tree schematic. As noted in that Figure, the Logic Tree is composed of four types of symbolic blocks, each having a separate function and meaning.



means of this rule of construction, the beginning of the task and all the necessary conditions and cues are firmly established.



have two exit, and only two exit, paths; one for the "yes" and the other for the "no" decision. Any information required to answer a decisional question represents knowledge necessary to the performance of the task.



Finally, the circle represents an exit or a jump to another portion of the Logic Tree.

Through the use of this block, the reader may jump over any unnecessary steps in the performance of the task to that location in the Logic Tree where the task procedure again becomes

relevant to him. Obviously, the circle has no exit path since it contains written instructions as to where in the schematic the reader should proceed.

All that remains of the Logic Tree schematic to be described are the connecting lines and the directional arrows. These elements do nothing more than graphically depict the various decisional paths open to the

reader. By means of such guidelines, the possibility of the reader departing from the logical sequence of the decisions is effectively precluded.

RULES OF LOGIC TREE DESIGN

The rules of Logic Tree design are intended to ease the effort of Logic Tree construction and to enhance the clarity and usefulness of the schematic itself. Common sense in the design of Logic Trees dictates that the more elementary the schematic, the more beneficial the Logic Tree will be to the student, the instructor and the training analyst.

At this stage, it demands little comment that Logic Trees can be constructed only to depict tasks and never to graphically describe a subject or general topic. The task can be mental, physical or a combination of the two, but it must have a definite starting point, a definite ending, and must be performed because of certain conditions or circumstances which are found to exist.

As well, the Logic Tree schematic should be so designed so as not to refer the user to any regulation or outside informational source, if at all possible. The Logic Tree is intended to supplant such informational sources.

Equally important, exceptions to the general rule and decisions or actions common to all major decisional branches should be placed near the beginning of the Logic Tree, thus eliminating the needless repetition of such blocks in each of the different trunk-lines of the Tree. Also with reference to exceptions to the general rule, the user will immediately find the exception and if it is relevant to him, can follow the decisional path pertaining to that exception without first traversing the decisions of the entire Tree.

Finally, by keeping the "Yes" and "No" beside the decision block at the very beginning of the exit line, by refusing to cross one directional line over another, by using sufficient directional arrows, and by numbering the symbolic blocks from left to right and from the top to the bottom of the page, the clarity and simplicity of the Logic Tree will be greatly enhanced.

THE LOGIC TREE AND MILITARY PERFORMANCE TESTING

The properly constructed Logic Tree has numerous uses in the process of course design, and obviously, each of these uses contributes somewhat to the development of effective performance testing devices. However, due to the limited scope of this paper, only those uses of the Logic Tree which are essential to test design will be discussed.

In accordance with the Systems Training concept as established by CONARC Regulation 350-100-1, the training analyst must minutely analyze the various tasks which he has selected for training. Such a Task Analysis is undertaken to disclose all the decisions which are essential to the performance of the task being analyzed.

At the Adjutant General School, the Logic Tree functions as the Task Analysis step in the Systems Engineering process primarily because it compels disciplined, logical thinking. Through the use of the Logic Tree, the analyst can readily determine the exact nature of the task and what skills and knowledges the student must master in order to perform the selected task.

The Logic Tree has inherent advantages over other Task Analysis methods namely because it requires the analyst to express each mental element of the task in the form of a question. By further requiring each question to be answered by a "yes" or a "no", the analyst is compelled into considering all possibilities and he can consequently uncover aspects of the task which would not have been so apparent under a less methodical approach.

Once the Logic Tree has been prepared, the creation of the performance test itself becomes vastly simplified. Since the Logic Tree graphically depicts every decision within the task and every end result of that task, the analyst need only pick the appropriate decisions and results he considers worthy of testing. By drawing a line through the chain of decisions so tested, the analyst need not worry about over-testing any particular variation of the task. In one procedure then, the training analyst has placed all the elements of the task before his evaluatory eye, and has ensured a comprehensive and valid examination. Less methodical approaches function chiefly as a means of documenting the analysis which has been undertaken, while the Logic Tree not only documents such analysis but constitutes the analytical tool itself.

To demonstrate the use of a Logic Tree in the development of a performance test, consider again the Logic Tree schematic shown at Figure number 2. This Logic Tree graphically represents a block of instruction presented in the Adjutant General School's Instructor Training Course.

It is the policy of the Adjutant General School that every instructor must not only command the training platform with confidence, but must also be able to continuously evaluate the effectiveness of his instruction. In pursuance of this policy, each instructor is given computer print-outs covering the students' performance on that instructor's examination. In particular, the instructor must be able to evaluate the students' responses to each question/problem included in the examination as disclosed by the Item Analysis print-out. Figure number 3 depicts a typical Item Analysis print-out. Note on that figure that items number 4 and 8 have miss rates in excess of ten percent, i.e. more than ten percent of the students in the class failed to answer those questions correctly. At the Adjutant

General School such miss rates are considered unacceptable and demand the immediate attention of the instructor.

When confronted by an excessive miss rate, the instructor can consider that one of two contingencies caused the problem: 1) his instruction was unclear and ineffective; or, 2) the test instrument was misleading and invalid. Since the instructor has in his possession a copy of the answer key, a copy of the test instrument and his own personal lesson plan, each of the causative factors can be explored. For those who would also add the possibility that the excessive miss rate was due solely to student lack of effort, the countervailing argument seems far too strong to allow such consideration. The School allows up to ten percent of the class to miss a question due to such causative factors of poor student motivation as headaches, poor scheduling of an examination, Spring Fever and whatever else would distract a student's attention from successful performance on an examination. Should a higher percentage of students be so distracted by such personal causative factors, then a re-evaluation of the entire course would seem warranted.

In the Instructor Training Course, the student is first presented the foregoing instructional information and is then presented with a practice version of the performance examination in order that he might practice his skill of self-evaluation. This practice version of the examination is shown at Figure number 4. Note that the examination first places the student in the position of an instructor of the administrative review of Disposition Forms, and that the Instructor Training student is given all the tools normally possessed by an incumbent instructor in the Adjutant General School. The student is then required to evaluate the Item Analysis print-out as found on the practice test instrument and determine if the excessive miss rates were due to ineffective instruction or due to errors in the design of the administrative review test which they administered to a hypothetical class.

For example, item number 4 on the TEST RESULT PRINT OUT discloses a miss rate of 13%. Such a miss rate is unacceptable and demands immediate action on the part of the instructor. The instructor (Instructor Training student) must then check the ADMIN REVIEW ANSWER SHEET KEY to discover that item number 4 dealt with the FROM block on the Disposition Form. Next the Instructor Training student must check the ADMIN REVIEW TEST INSTRUMENT to determine if the unacceptable miss rates were caused by some error in the design of the test such as smudged or illegible printing. By merely looking at the FROM block on the ADMIN REVIEW TEST IN-STRUMENT, the instructor can readily perceive that the printing is legible and if the hypothetical student who was administered the ADMIN REVIEW TEST INSTRUMENT had known the subject matter of administrative review, he would have recognized that the Disposition Form came from the Adjutant General and not from the Administrative Services Division. Obviously, if the test instrument is not defective, then ineffective instruction must have caused the excessive miss rate and a review of that portion of the lesson

plan covering the FROM block is in order. The Instructor Training student must then examine the abbreviated LESSON PLAN found on the test to determine which paragraph of that LESSON PLAN need be reviewed. In this particular case, paragraph number 4.d. needed review and the Instructor Training student would transfer that information to the Answer Sheet and mark the answer block opposite paragraph 4.d. in Column A (answer block number 4). Had the excessive miss rate been caused by an error in the test design, then block number 17 on the answer sheet would have been marked. Item number 12 on the TEST RESULT PRINT OUT concerns itself with a test design error, namely a missprinting in the Inclosures portion of the Disposition Form. Obviously, the test is not completed until the cause for each unacceptable miss rate has been isolated and identified. Following this practice test, the Instructor Training student is then required to complete a graded examination which takes exactly the same form and requires the execution of exactly the same task.

In relating this particular examination back to its parent Logic Tree, it becomes readily apparent that the Logic Tree depicted each of the three end results which were finally adjudged to be worthy of testing: 1) the training was effective as disclosed by an acceptable miss rate; 2) the unacceptable miss rate was due to ineffectual instruction; and, 3) the excessive miss rate was generated by faulty test design.

To denote that a particular end result had been tested, a colored line was drawn through the appropriate blocks in the Logic Tree. Each of the possible end results was tested at least once. For example, the first end result above was tested in item number 1 on the TEST RESULT PRINT OUT. That particular item tested blocks 1, 3, 9, 10, and 4 on the Logic Tree and a colored line denoted that decisional path. The second end result above was presented in item number 4 on the TEST RESULT PRINT OUT. Consequently, item number 4 tested blocks 1, 3, 9, 14, 18, 23, 19, 20, 24 and 21. A different colored line was drawn through that set of blocks. Finally, the last possible end result was presented to the student by item number 12 on the TEST RESULT PRINT OUT. That item tested blocks 1, 3, 9, 14, 18, 23, 19, 20, 16, 11 and 5. A third color was used to indicate this final decisional path. Through this technique of first discovering every possible decision within the task of evaluating an Item Analysis Print Out and every possible end result, the task in its entirety could be presented to the student both during the instruction and during the examination.

CONCLUSION

The Adjutant General School does not consider the Logic Tree as a panacea for all training problems, but consistently this analytical device has proven itself to be an efficient and valuable tool in the preparation of realistic, objective and comprehensive performance tests which are also capable of providing specific feedback information.

Figure No. 1

LOGIC TREE FOR:

EVALUATION OF TEST RESULT PRINTOUTS

To utilize an Item Analysis test result print-out in order to eliminate deficiencies in instruction and test design.

Conditions/Cues: Receipt of an Item Analysis test result print-out,

and access to the appropriate answer sheet key, Test Instrument and Lesson Plan.

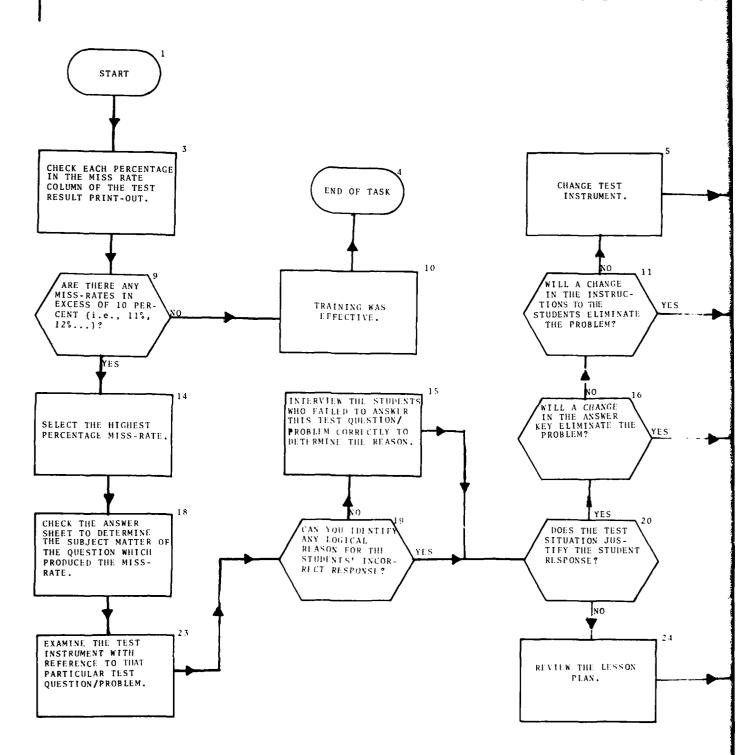
Source Data

USAAGS Reg 350-2, dtd 7 May 69 W/C1 USAAGS Reg 350-100, dtd 1 Jul 68 W/C1

SUPERSEDES: NA

25 Aug 71

FIGURE NO.



FRE NO. 2



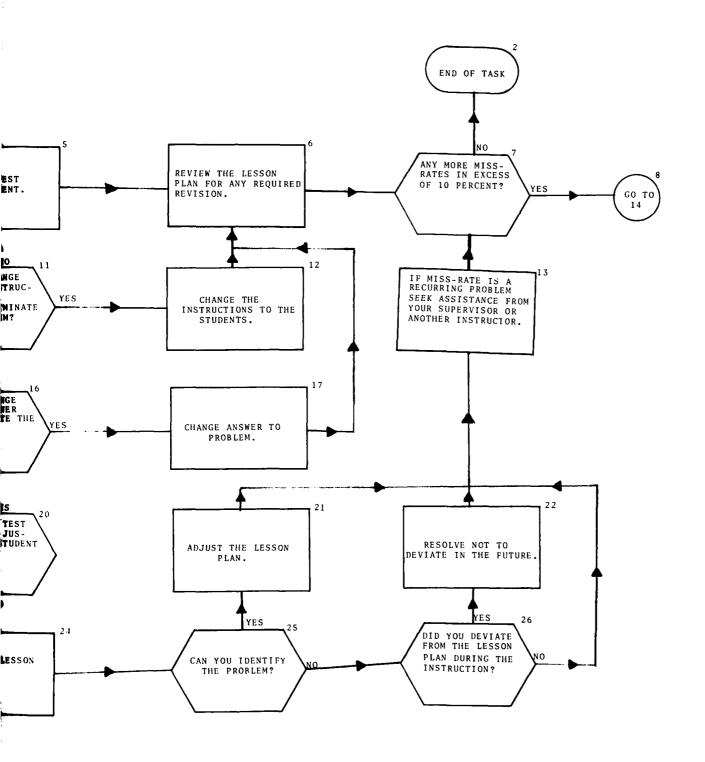


FIGURE NO. 3

ITEM ANALYSIS DATE - 19AUG70

CARD NO. - 5 OF 5

COURSE - AGOBO CLASS - 71-02		TEST - AD SVCS SITUATION - AD REVIEW	CARD TYPE - B RAW POSS - 25
ADMINISTRATIVE	REVIEW	CARD 5-5	
QUES	PUN	UNPUN	MISS RATE
1	4	47*	7%
2	4	47*	7%
3	49*	2	3%
4	35*	16	31%
5	5	46*	9%
6	49*	2	3%
7	1	50*	1%
8	8	43*	15%
9	4	47*	7%
10	46*	5	9%
11	2	49*	3%
12	5	46*	9%
13	5	46*	9%
14	47*	4	7%

The * indicates a correct student response.

SUPPLEMENT 2-2-1

ADMIN REVIEW - DISPOSITION FORM

1.	Office	Symbol
----	--------	--------

2. Subject

3. 10

4. FROM

5. SATE/Originator

6. Paragraph 1

7. Paragraph 2

8. Paragraph 3

9. Paragraph 4

10. Authority Line

11. Signature Block

12. Inclosures

13. Histribution

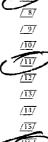
14. Copies Furnished

15. Page Number

16. Number of Copies



/1/





ADMIN REVIEW ANSWER SHEET KEY

HSSON PLAN

(Abbreviated for lest Purposes) ADMINISTRATIVE REVIEW OF THE DESPOSITION FORM

A. Heading of the Disposition Form.

B. Body of the Disposition Form.

COURS

ADMI

QUES

2

8

9

10

11

12

2-

ITEM ANALYSIS EATE - 190CT70

CARD NO. - 5 OF 5

	GOBC 1-8	TEST - AD SVCS C SITUATION - AD REVIEW	CARD TYPE - B RAW POSS - 32
APMINISTRA	TIVE REVIEW	CARL 5~5	
QUES	PUN	UNPUN	MISS RATE
1	4	48*	7%
2	3	49*	5%
5	1	\$1*	1%
1	45*	7	13%
5	46*	6	115
6	17.1	5	9%
-	19*	3	5%
8		52*	
9		52*	
t o	1	51*	1%
11	42*	10	19%
12	1.5	39*	25%
13		52*	
14		52*	
15		52*	
16	32*	15	28%

TEST RESULT PRINT OUT

DISPOSITION FORM

For use of this form use AT 3.00 - 1.3 the proposed option - 1 fine Adjusted Compand 1.00 to

FERRICE OF OTHER SYMBOL

SUBJECT

SUBJECT

REFERENCE OR OFFICE SYMBOX
A.U.T.Y.C.

Sponsor for New Officer

t Purposes)

DISPOSITION FORM

ITC PT 1P

GENERAL SITUATION:

l

You are an instructor in the United States Army Adjutant General School and you have just received the test result print outs for the first class which you have instructed on the Administrative Review of Disposition Forms. You decide to evaluate the item analysis portion of the test results in order to determine which areas of the Lesson Plan should be reviewed. In addition, you decide to review the test instrument based on the information contained in the item analysis in order to determine if any corrections in the test are required.

$\underline{\text{REQUIREMENT}}:$

Based on the information contained on this test supplement, place a check mark in the numbered block on the answer sheet under Column A to denote which paragraphs of the Lesson Plan should be reviewed, and under Column B to denote an error in the construction of the test instrument which contributed to the unacceptable miss rate.

	ANSWER SHEET	
Paragraphs of the Lesson Plan.	Column A Lesson Plan should be reviewed.	Column B Test instrument contains an error.
4.		
a.	<u>/ T / </u>	/ 14 /
b.	/ 2 /	/ 15 /
с.	/3/	/ 16 /
d.	/4/	/ 17 /
e.	<u>/ 5 /</u>	/ 18 /
5.		
a.	/ 6 /	/ 19 /
b.	<u>/ 7 7</u>	/ 20 /
c .	/_8/	/ 21 /
d .	/ 9 /	<u>/ 22 /</u>
6,		
a.	/ 10/	/ 23 /
ь.	<u>/ 11</u> /	/ 24 /
¢.	/ 12/	/ 25 /
u.	<u>/_13/</u>	/ 26 /

LESSON PLAN

(Abbreviated for Test Purposes)

ADMINISTRATIVE REVIEW OF THE DISPOSITION FORM

- A. Heading of the Disposition Form.
 B. Body of the Disposition Form.
 C. Closing of the Disposition Form.

SECTION 1-INTRODUCTION

- 1. Attention.
- 2. Motivation.
- 3. Objectives.

SECTION 11-BODY

- 4. First Main Teaching Point. Heading of the Disposition Form.
 - a. Office Symbol or Reference.
 b. Subject Block.
 c. TO Address.
 d. FROM Address.
 e. DATE/ORIGINATOR.
- 5. Second Main Teaching Point. Body of the Disposition Form.
 - Detection of errors in spelling, grammar and punctuation in body of DF.
 Paragraph numbering.
 Use and lettering of subparagraphs.
 The Modified block style format.
- 6. $\underline{\text{Third Main Teaching Point}}$. Closing of the Disposition Form.

 - a. Use of the Authority Line.
 b. Format and use of the Signature Block.
 c. Identification of Inclosures.
 d. Use of Copies Furnished and the preparation of copies.
 e. Continuation Pages and page numbering.

SECTION 111-CONCLUSION

- 7. Questions.
- 8. <u>Summary</u>.
- 9. Closing.

LESSON PLAN

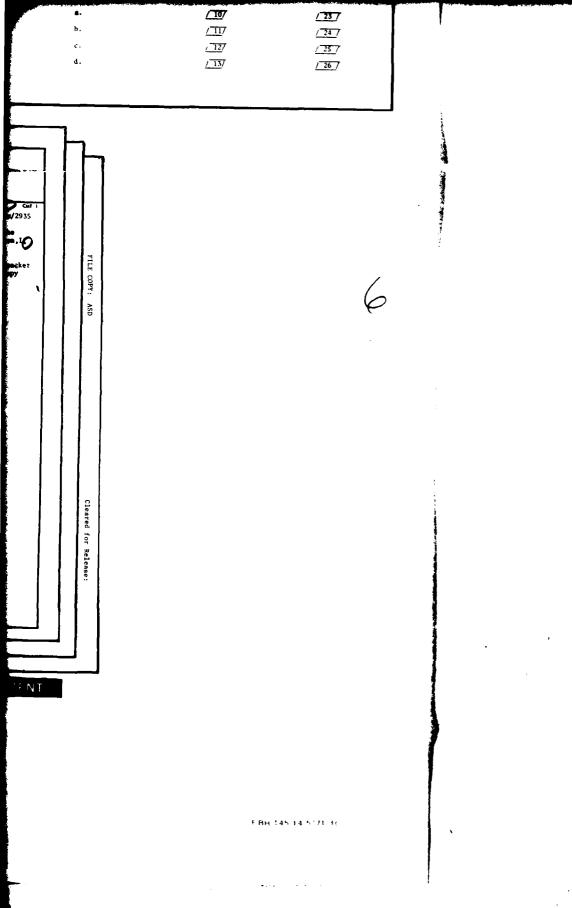
FIGURE NO. 4

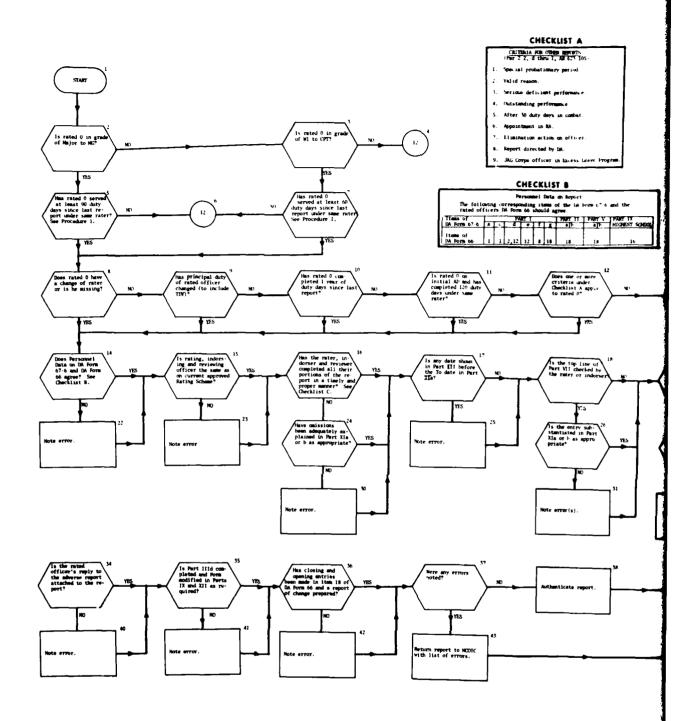
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REFERENCE OR OFFICE SYMBOL	0-15 the proponent agency is The Adjutant General's Office SUBJECT	i
AJJAG	Sponsor for New Officer	
10 65	PARE 15 May 1974 Cm 1 21.7 Campbell7/kw/2935	1
division. Since CPT	Scot is tentative theduled to be assigned to your section. 10	
 In accordance wi will be forwarded td of the letter will b 	th General Johns' policy, a letter and a division welcome packet CPT Scott not later than 20 May 1974 and an information copy of Turnished this office.	
I Incl	к. к. GiaMilL LTC → GC Adjitant General	
_		
_		
A 181 2496	REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL I FEB 63 UNLESS SOOMER EXHAUSTED	4

FIGURE NO. 4

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CHECKLIST A

THAN FOR OTHER BRENTS
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CHECKLIST B

_ c	CHECKLIST B					
To the	ria	m 1 (Duta	on Report		
	odin 66	1 1 10	- C	if the DA I	orm o' o	and the
		H HALL		PORT IT	PART Y	ויאדר וז
	•			alb	alb	HIGHEST SCHOOL
2.12	12	•	18	18	18	16

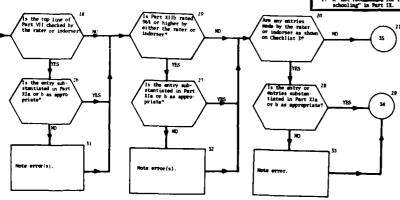
CHECKLIST C

			ROUSER		
Items of DA Forms 67-5	RATER	Observed Rated 0 less than 60 duty days for Co Gr and NO and less than 90 duty days for other 0	Observed Rated 0 for 60 or more duty days for Co Gr and WO and for 90 or more duty days for other 0	Revioues	
Part Hc	¥	X	X		
Part illa	X				
ь		X	X		
c				X	
Part IV	X.		X		
Part Vi	X		X		
Part VII	X		x		
Part VIII	X		X		
Part IX	X		x		
Part X	X		X		
Part XIs	_X_				
ь		X	х		
Part XIIa	X		X		
b	. х		x	I	

CHECKLIST P

Entries that constitute an Adverse Report and require referral to the rated officer for his reply.

- e. A rating of 5 in Part IV, VI or X. A rating of unsatisfactory in Part VII.
- A "not recommended for promotion" rating in Part VIII.
- d. A comment in Part XI reflecting on the character of the rated officer
- A low rating of 20 percent or belo in Part XIIb.
- f. A "not recommend for further schooling" in Part IX.



No report re-

PROCEDURE 1

DETERMINATION OF PERIOD COVERED

- 1. FROM Date:
- Step 1: Go up from last entry in "Type of Report" column to where an entry is shown as 67-6 or $\frac{1}{4}$ or $\frac{1}{4}$.

Step 2: Go down one line from the above entry and read the date in the "Miffective date" column on that line. That date is the PROM date for the report.

- 2. TO Date: The date before the effective date of change of rater or change of duty of the rated officer.
- 3. Duty Days and Other Days

Step 1: Determine total number of inclusive calendar days between the FROM date and TO date. a. Determine inclusive days in first month to end of month.

- b. Determine the total number of days in any additional menths of the period covered. Days for menths are as follows:

Apr 30 May 31 Jun 30

*20 days in 1972, 1976, 1980 and every following 4 years (Leap Year)

c. Add the days for the first month and the total days of the rem ths together.

Step 2: a. Add the number of non-duty days shown in the "Non Duty Days column in Item 18 of the Dk Form 64, shown on and after the line shore the FRON date use obtained.

- b. Determine the number of days in the period covered, if any, that the rated officer had a different rater (other than the ourront rater) for periods of less than 80 days for company grade and 80 and less than 90 days for other officers and was not rated.
 - c. The total of a end b above are OTHER DAYS.
- Stop 3: Subtract OTHER DAYS from the total calender days. The re-mainder is <u>DUTY DAYS</u>.

FBH 68-5 3/71 1c

LOGIC TREE POR:

AUTHENTICATION OF AN OFFICERS EFFICIENCY PEPOPT

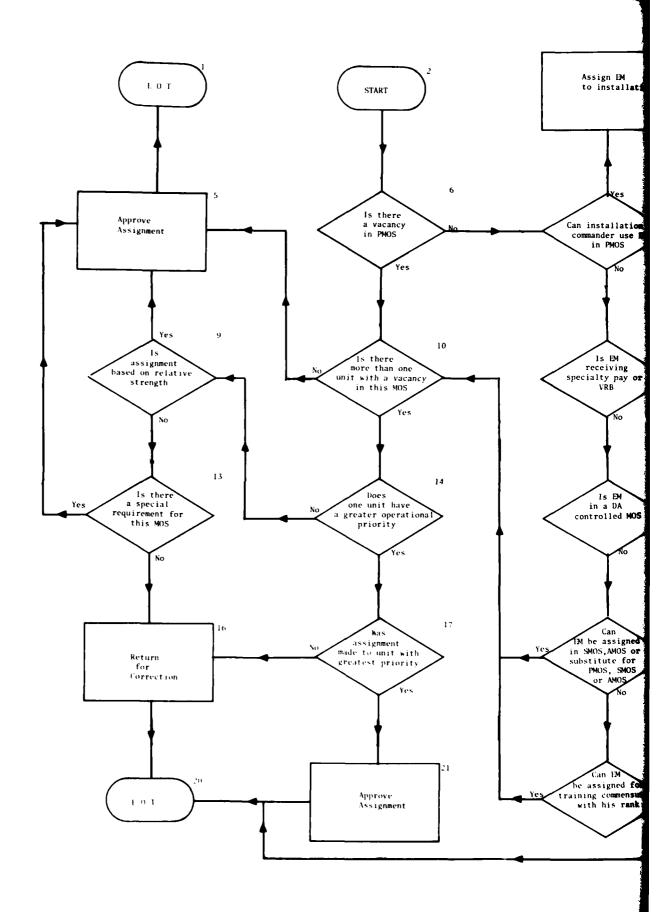
Task: Review a completed officers efficiency report for correctness.

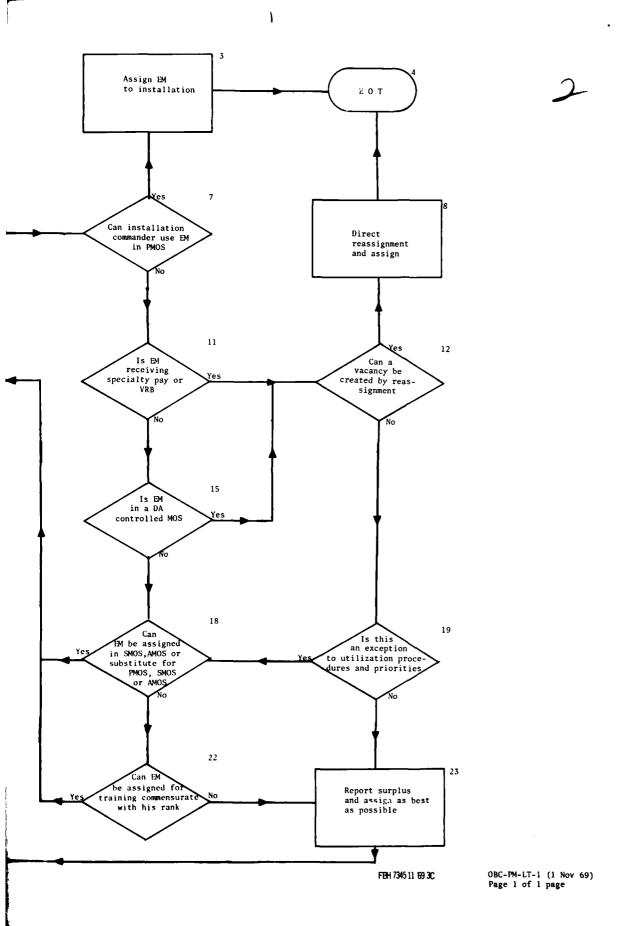
Conditions/Cues: Receipt of an officers efficiency report, officers DA Form 66 and the organization rating scheme.

Source Data

OBC-PA-LT-2 (1 Mar 71)

AR 623-105





LOGIC TREE FOR:

REVIEW OF INITIAL ASSIGNMENT OF PERSONNEL IN GRADES E2 THRU E6 (OBC-PM-LT-1)

Task: To review initial assignment of personnel in grades E2 thru E6.

Conditions/Cues: Receipt of recommended initial assignment list and access

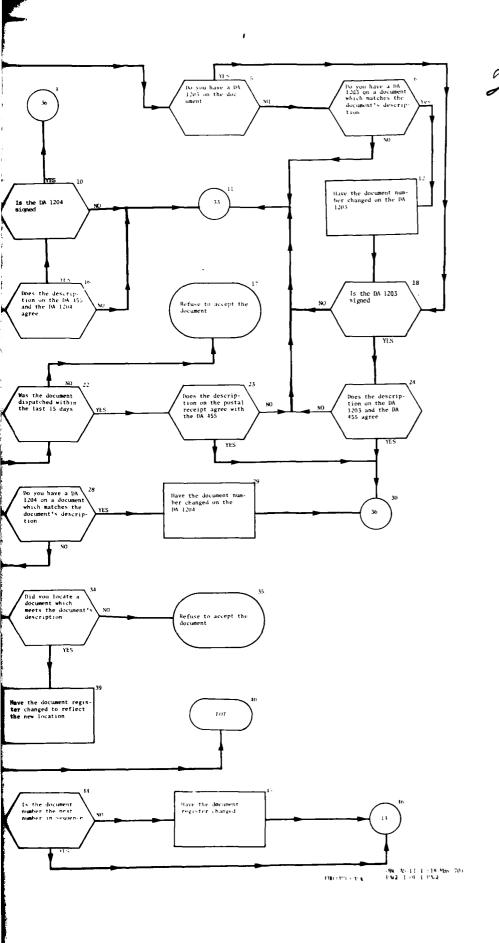
to strength/MOS reports, operational priorities and special

assignment requirements.

Source Data

AR 600-200, dtd 24 March 65 W/CI-33

OBC-PM-LT-1 (1 Nov 69)



de Viene

LOGIC TREE FOR:

INVENTORY OF CLASSIFIED DOCUMENTS (OBC-AS-LT-1)

To inventory classified documents prior to accepting or refusing to accept a classified document account.

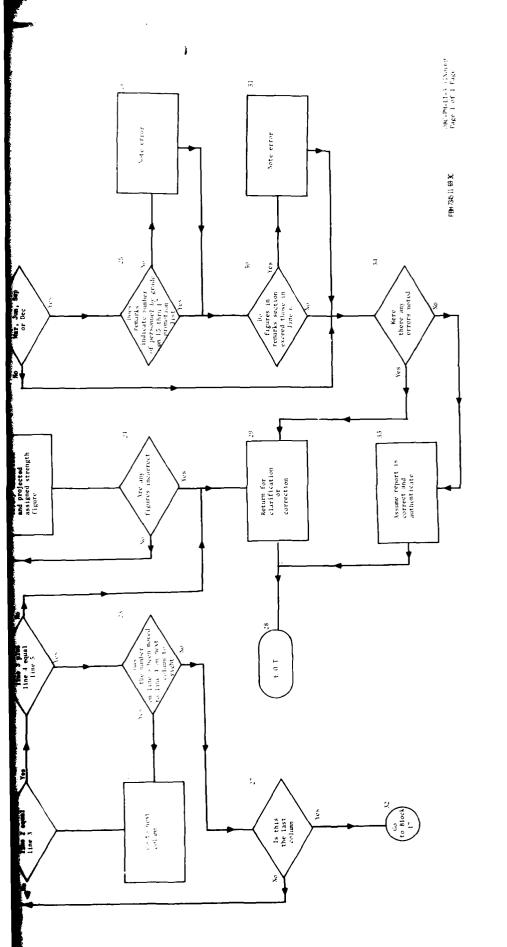
Conditions/Cues:

Receipt of orders assigning duties as classified custodian. Access to Document Register, classified document file, Destruction Record and classified document receipts.

Source Data

AR 380-5

OBC-AS-LT-1 (18 May 70)



LOGIC TREE FOR:

AUTHENTICATION OF ENLISTED PERSONNEL ELIGIBLE FOR TEMPORARY PROMOTION REPORT, DA FORM 2644-R (OBC-PM-LT-3)

Task: To approve and authenticate DA Form 2644-R prior to dispatching to higher headquarters.

Conditions/Cues: Receipt of DA Form 2644-R.

Source Data

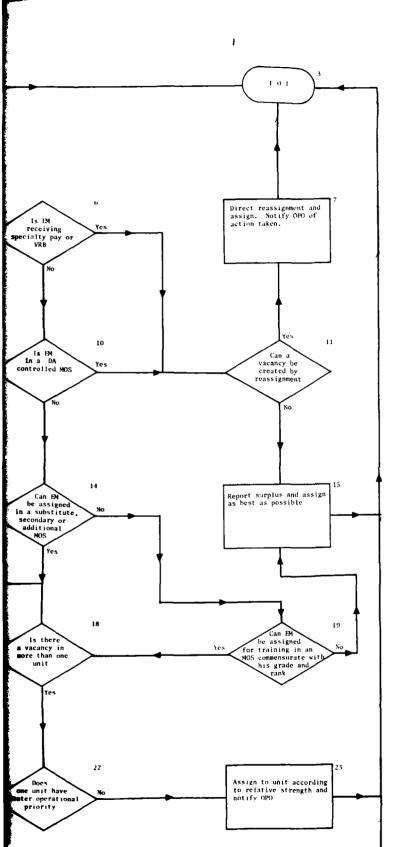
AR 600-200

AR 600-16

AR 600-17

DA Pam 600-8

OBC-PM-LT-3 (1 Nov 69)



FBH 7345 11 69 3C OBC-PM-

OBC-PM-LT-2 (1 Nov 69) Page 1 of 1 Pages

LOGIC TREE FOR:

ASSIGNMENT OF PERSONNEL IN GRADES E7 THRU E9 (OBC-PM-LT-2)

Task: To determine initial assignments of personnel in grades E7 thru E9.

Conditions/Cues: Arrival of personnel in grades E7 thru E9 and access to

individuals personnel records, requisitions, MOS Inventory

reports and operational priorities.

Source Data

AR 600-200, dtd 24 March 65 W/C1-33

OBC-PM-LT-2 (1 Nov 69)